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THIRD

BIENNIAL REPORT

OF THE

STATE ENGINEER

TO THE

GOVERNOR OF UTAH.

1901 and 1902.

SALT LAKE CITY
STAR PRINTING COMPANY.
1903.

SALT LAKE CITY, UTAH,
December 31, 1902.

Hon. Heber M. Wells, Governor:

DEAR SIR:—In pursuance of the requirements of law, I herewith submit the third biennial report of this office, and trust the same may receive your approval.

Respectfully,
A. F. DOREMOUS,
State Engineer.

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Irrigation in the State of Utah, being of fundamental importance, has been made the function of the State Engineer's office, and is accordingly the sole subject of this report.

At the last session of the Legislature a law was passed, entitled "An Act defining the duties of State Engineer; providing for the creation of water districts and for the appointment of water commissioners for each district; providing for the proper measurement and division of water; providing for the reclamation of stored water, and repealing Chapter 8, Title 63, Revised Statutes of Utah, 1898."

Section 5 of the above entitled act reads as follows:

"DUTIES:—The State Engineer shall make or cause to be made measurements and calculations of the discharge of streams from which water shall be taken for beneficial purposes, commencing such work upon those streams which are most used for irrigation or other beneficial purposes. He shall collect facts and make surveys to determine the suitable location for constructing works for utilizing the water of the state and to ascertain the location of the lands best suited for irrigation. He shall examine reservoir sites and shall in his reports embody all the facts ascertained by such surveys and examinations, including, wherever practicable, estimates of the costs of proposed irrigation works and of the improvement of reservoir sites. He shall become conversant with the waterways of the state and the needs of the state as to irrigation

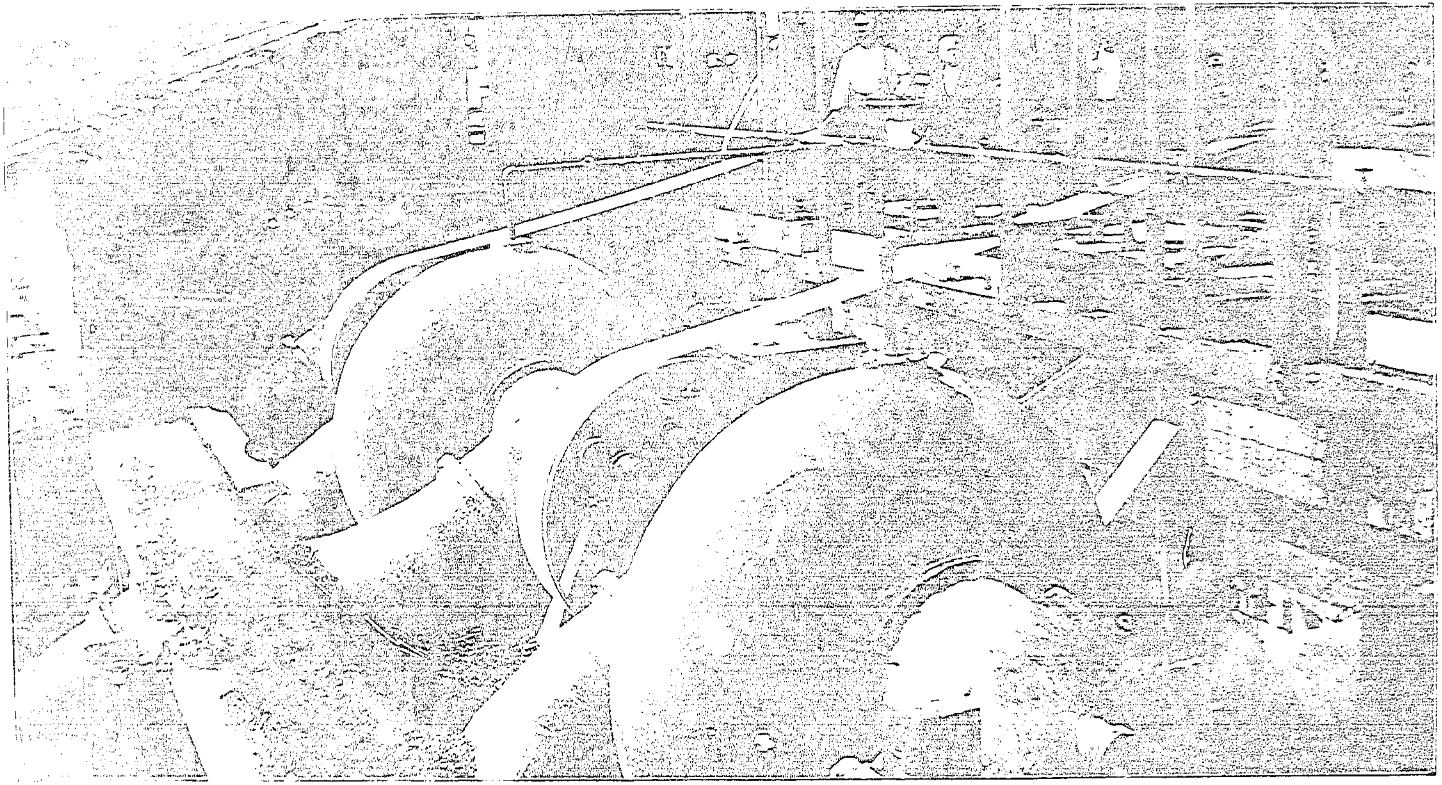
matters, and in his reports to the Governor he shall make such suggestions as to the amendment of existing laws or the enactment of new laws as his information and experience shall suggest. He shall keep in his office full and proper records of his work, observations and calculations, all of which shall be the property of the state."

As the appropriation bill which was passed at the same Legislative session contained no provision for paying expenses such as would have been unavoidable in carrying out the requirements of the above quoted section, no work which involved more than petty personal expenses has been accomplished. Considerable general information on the required subjects has, however, been collected and is incorporated under appropriate headings in this report.

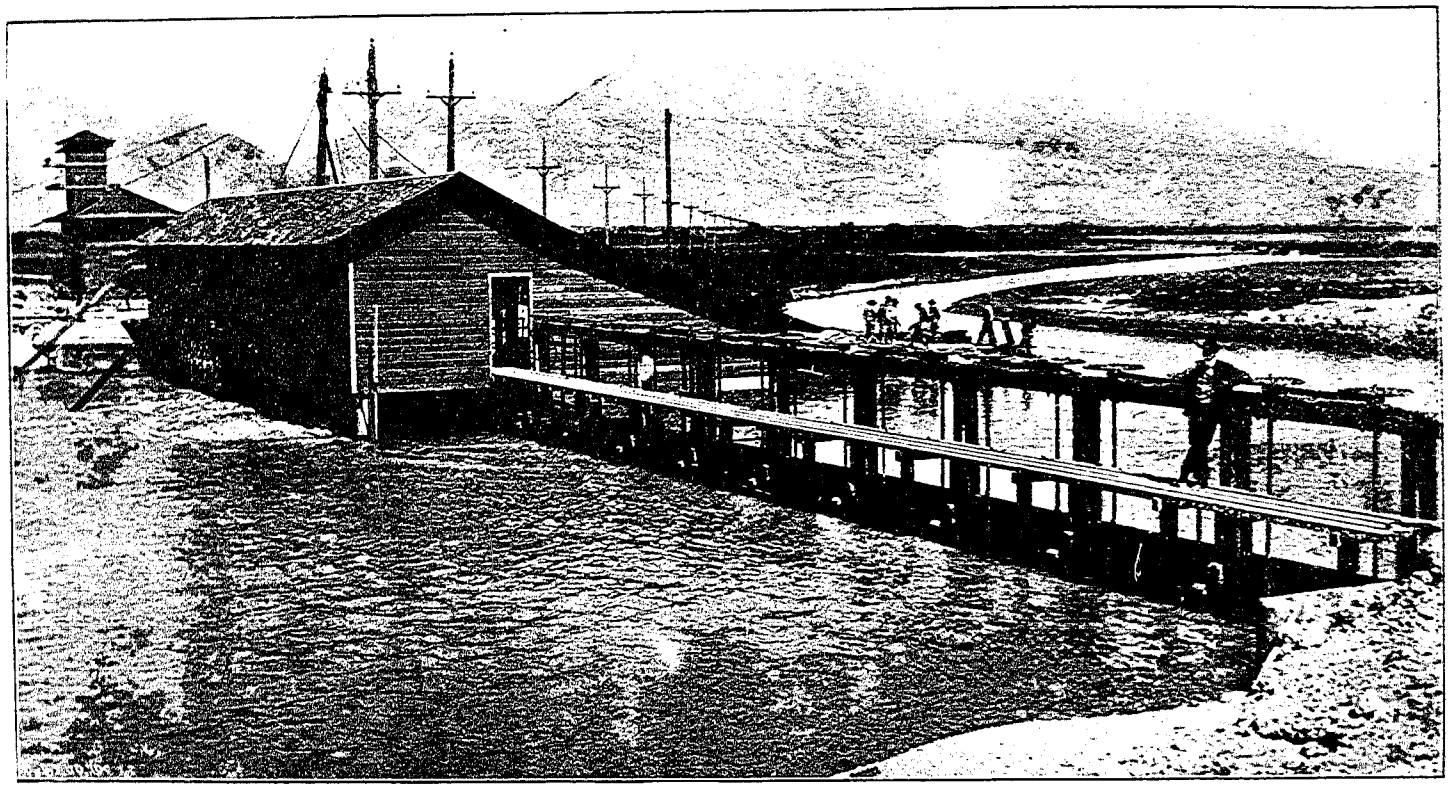
Under the requirements of sections 10, 11 and 24 of the above named Act, plans and specifications have been submitted, examined and approved, and the required fees have been collected and paid into the State Treasury for the following described dams:

Name of Dam.	County where located	Kind of material	Dimensions		Slope		Reservoir capacity, acre-feet
			Height in feet	Length on top	Of face	Of back	
Bear Wallow.....	Davis	Earth	27	536 ft.	3 to 1	1½ to 1	58.02
Woodruff Creek.....	Rich	Earth	36	500 ft.	3 to 1	2 to 1	188.00
East Park.....	Uintah	Earth	24	2050 ft.	3 to 1	1½ to 1	1,209.26
Lewis Power Co. 1....	Beaver	Earth and Masonry	73	202 ft.	2½ to 1	1½ to 1	913.00
Lewis Power Co. 2....	Beaver	Earth and Masonry	75	301 ft	2½ to 1	1½ to 1	935.00
Lewis Power Co. 3....	Beaver	Earth and Masonry	34	338 ft.	2½ to 1	1½ to 1	214.00
Rocky Ford.....	Sevier	Earth	25	811 ft.	3 to 1	2 to 1	2,115.00

Section 18 of the said Act requires that the water "shall be divided among the several ditches according to the prior rights of each respectively." This very just and necessary requirement, under proper conditions, becomes ludicrous in the extreme under conditi ons where every right is the subject of dispute,



UTAH LAKE PUMPS



PUMPING PLANT AND RIVER GATES

where none are definite enough to be describable and are not likely to be known until after long and expensive litigation. This, together with the delinquency of many of the boards of county commissioners in creating water districts and appointing water commissioners and the failure of others to compel appropriators of water to construct and maintain headgates and measuring devices, has had the effect of nullifying all that portion of the Act which relates to the measurement and apportionment of the water.

The years 1901 and 1902 have been conspicuous for deficient precipitation and the consequent lack of water. The records in the local office of the Weather Bureau show an accumulated deficiency of precipitation for these years of 4.79 inches. For the year 1902 the deficiency has been 4.68 inches, or a shortage of over twenty-eight per cent of the mean annual depth. Deposits of snow which had never before been known to disappear and which were regarded previously as perpetual, have been entirely dissipated during the past summer through the combined influence of almost ceasless sunshine and a highly absorbent atmosphere. Many perennial springs ceased to flow and lakes and streams generally decreased in volume to the lowest known stage.

Utah Lake, which is the principal source of supply for the Jordan River valley, receded so low as to practically prevent outflow into Jordan River, which is the only outlet of the lake. This deprived the five great canals which head in the Jordan River of their water supply, and the growing crops on the major portion of the land of the valley were threatened with destruction. Hot winds and a scorching sun conspired to hasten the calamity.

To forestall the impending disaster resort was had to pumps which were hastily installed at the head of the river and operated to raise the still receding waters of the lake over the bar and into the dried channel of the river below, from where the pumped water flowed down to and restored the supply for the canals.

This pumping plant, while not yet complete, has cost about $50,000.00, and in capacity is entitled to be classed among the largest in the world. When fully completed the cost will reach the sum of $65,000.00. The machinery

consists of four double-suction, 40-inch Byron Jackson horizontal centrifugal pumps, each having a capacity of 100 cubic feet per second, or a combined capacity of 400 cubic feet, equaling 3,000 gallons per second; four 100-horsepower, 440-volt Westinghouse induction motors, one vacuum priming pump, one 3-horsepower motor for propelling vacuum pump, three 170-Kilowatt transformers for reducing current from 16,000 to 440 volts.

The cost of the machinery in place was $30,028.00. Electrical power is employed and is supplied by the Salt Lake City Water & Electrical Power company. The power is transmitted from motors to pumps by belt connections. The plant was installed under the supervision of Mr. Frank C. Kelsey, who was the engineer for the canal companies.

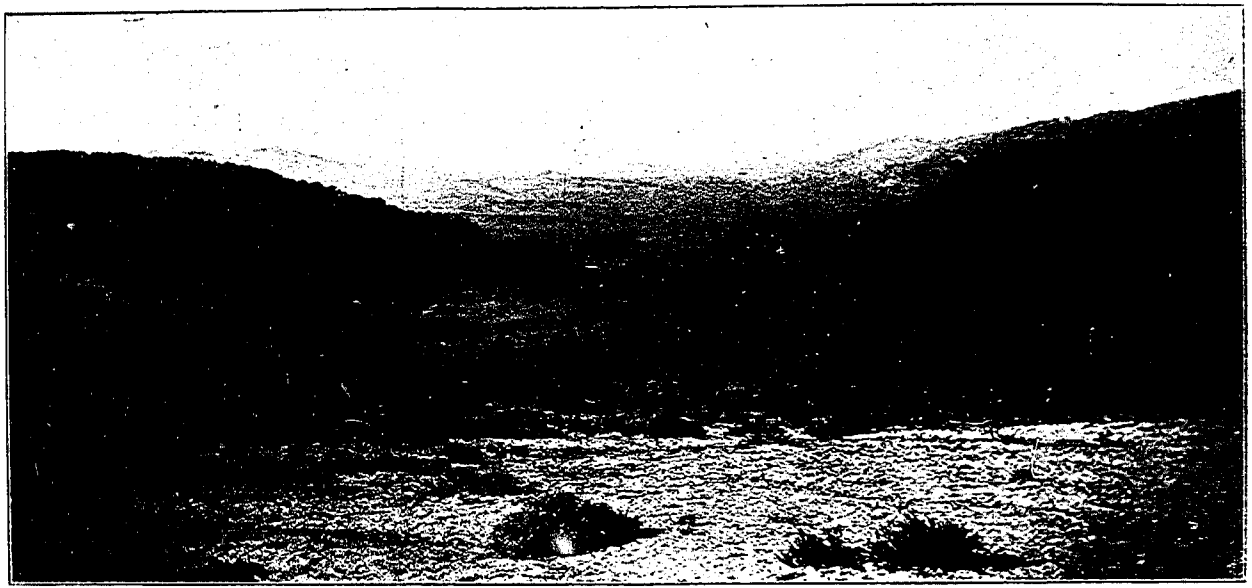
The combined effect of evaporation and of operating these pumps has been to reduce the lake level to a stage heretofore unknown and below a point where it is possible for any of the water to flow naturally out of the lake into the Jordan River. Until the lake shall have been restored to the outflow level pumping must be continued. Fortunately the prospect is for a more plentiful water supply for the ensuing year and discontinuation of the pumping. While it is hoped that there will be no further use for this pumping plant, it will be completed and kept in reserve for occasions similar to that which induced its erection.

A battery of nine 8-ft. gates provided with screw hoisting gear is placed in the river channel near the pumps to permit the passage of water from the lake into the river whenever the water is high enough to induce a sufficient flow. When the pumps are in use these gates are closed to prevent the pumped water from flowing back into the lake.

While the work at Utah Lake has been on a large scale, it is none the less typical of the general effort that has been exerted throughout the state to protect the crops against the prevalent drought. The result of this general effort has been a fair yield, notwithstanding the abnormity which has characterized the water supply.

While the immediate effect of the shortage in the water supply has been discouragement and apprehension that in some cases approached consternation, the ultimate

SITE OF MAMMOTH RESERVOIR DAM



GOOSEBERRY BASIN.

effect promises to be more beneficial than hurtful. Scarcity has made plain the need of some means of insurance against recurrent drought and led to the discussion and development of plans for utilizing the waste water or supplementing the supply of the several systems.

Principal among the plans which have been developed for this purpose are those upon which work has been begun by the Mammoth Reservoir company and the Weber Reservoir, Power & Irrigation company. Both are organizations recently incorporated under the laws of Utah, and the work contemplated by each is of such magnitude and importance as to deserve the following brief description:

The Mammoth Reservoir company's plan is designed to provide a supplemental supply of water to lands in the San Pete and Juab valleys which are now inadequately watered from the San Pitch river and Salt creek, respectively. To provide this additional supply the flood and winter waters of Gooseberry creek are to be stored in Gooseberry valley and from there conducted by means of a tunnel, about two and one-half miles in length, through the crest of the Wasatch range and there turned into one of the several streams which are the sources of the San Pitch river.

At a point some distance down the stream part of the water is to be recovered and conducted in suitable channels along the slopes to the head of Salt creek, from where, commingled with the creek water, it will enter the system of ditches which now serves the Juab valley lands. In like manner the unrecovered portion of the water, commingled with that of the San Pitch, will flow onto the lands of San Pete valley through the system of ditches which serves the lands of that valley.

Gooseberry creek is a branch of Price river and a tributary of Green river, and has its source in the immense banks of snow that abound in the hills surrounding Gooseberry valley. Gooseberry valley is situated in T. 13 S., R. 6 E., of the Salt Lake meridian, and at an elevation of about 8,400 feet above the sea.

The plan is to convert this valley into a reservoir by means of an earthen dam, about 100 feet high, to be built across the narrow gorge through which Gooseberry creek

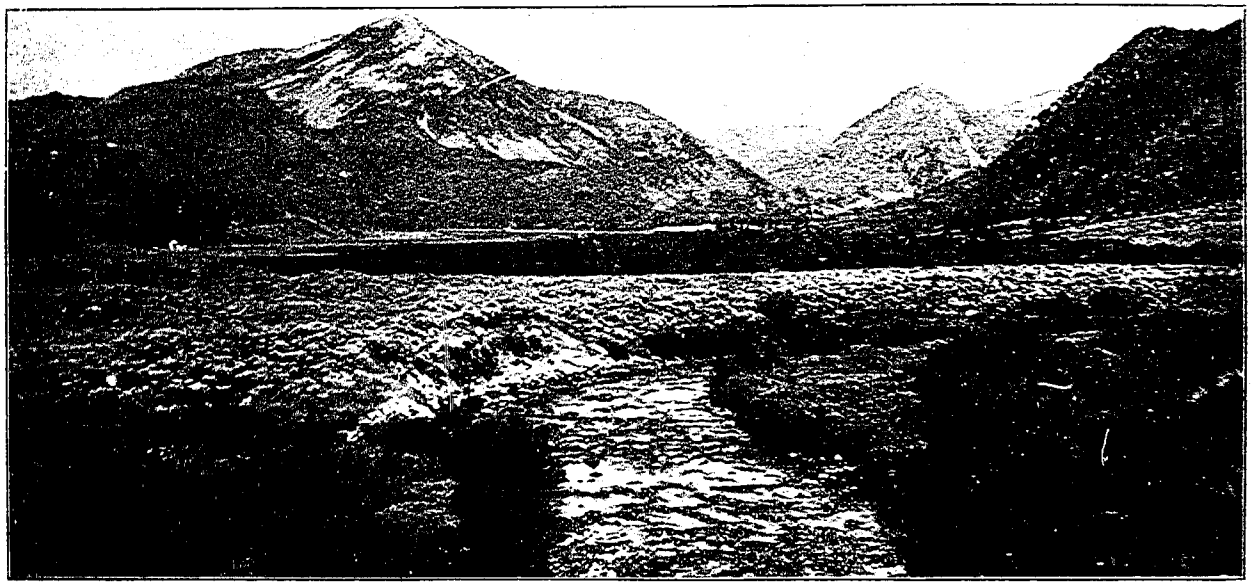
flows out of the valley. The reservoir so formed will have a capacity of about 25,000 acre-feet. The whole work is estimated to cost in the neighborhood of $400,000.00. About $70,000.00 have already been expended in securing the site, for engineering work and in preparing the foundation. It is a co-operative rather than a speculative proposition and none but actual users of the waters are subscribers to the capital stock.

The Weber Reservoir, Power & Irrigation company's plans contemplate, in short, the perfection of the entire Weber river irrigation system. This is the first successful effort to unite the numerous conflicting ditch and district interests, which, for the past twenty-five years have been contending one against the other over the apportionment of the Weber river water, into a single compact company for the purpose of common protection and growth.

The execution of these plans involves the construction of at least one dam on each of the several forks of the river to provide reservoir capacity for storing all the flood and winter water of the system. Six of these reservoir sites have already been secured. The two chief dams will be on the main fork of the stream, where considerable preliminary work has been done. One of these dams is planned to be seventy-five feet in height and 3,300 feet long on top. The surface area of the reservoir so formed will be about 1,600 acres and the capacity about 40,000 acre-feet.

The stored water will be utilized, first, to supplement the present supply to lands of the system in Summit, Morgan, Weber and Davis counties, and next in providing water for adjoining lands now wholly without a water right. In effect, the carrying out of these plans will fully insure the present development and permit the greatest extension which the whole supply of water fully utilized will justify.

On its passage from reservoir to field the water will, at various points en route, be relieved of its power, which will be distributed to desirable points and be used for various purposes of the system. The plans contemplate the full use of all the water of the system for both power and irrigation. It is difficult to foretell the advantages



LARRABIE BASIN—WEBER RIVER SYSTEM.

HEAD OF WILBER RIVER SYSTEM.

which this double use of the water will bring, but if use for each single purpose is profitable the dual use here contemplated must be doubly so.

Chief among the projects that are being discussed for the betterment of the water supply are the Utah lake, the Strawberry valley and the Bear lake schemes.

The Utah lake scheme is the most important, as it effects more land and a greater number of people than any other project in the state. Plans for improving the lake as a source of water supply have been discussed in different forms for ten years or more, but nothing worthy of the situation and possibilities has so far been undertaken. Great interest in this project has been reawakened through recent action of the State Irrigation Congress, which declared it to be the most worthy of government attention and action under operations of the recent reclamation act of Congress. Under existing conditions Utah lake furnishes, in ordinary seasons, a partial supply of water to about 45,000 acres of land now under the canals that have their source in the Jordan river. In seasons of scarcity the supply is entirely insufficient for this area, and great loss in crops results.

The lake and its marshes expose a surface of about 100,000 acres to evaporation, and the loss of water from this cause is more than is needed to fully irrigate all the land in Salt Lake county, which lies below the lake level. The plan now under consideration contemplates curtailment of this loss by increasing the depth and decreasing the area of the lake.

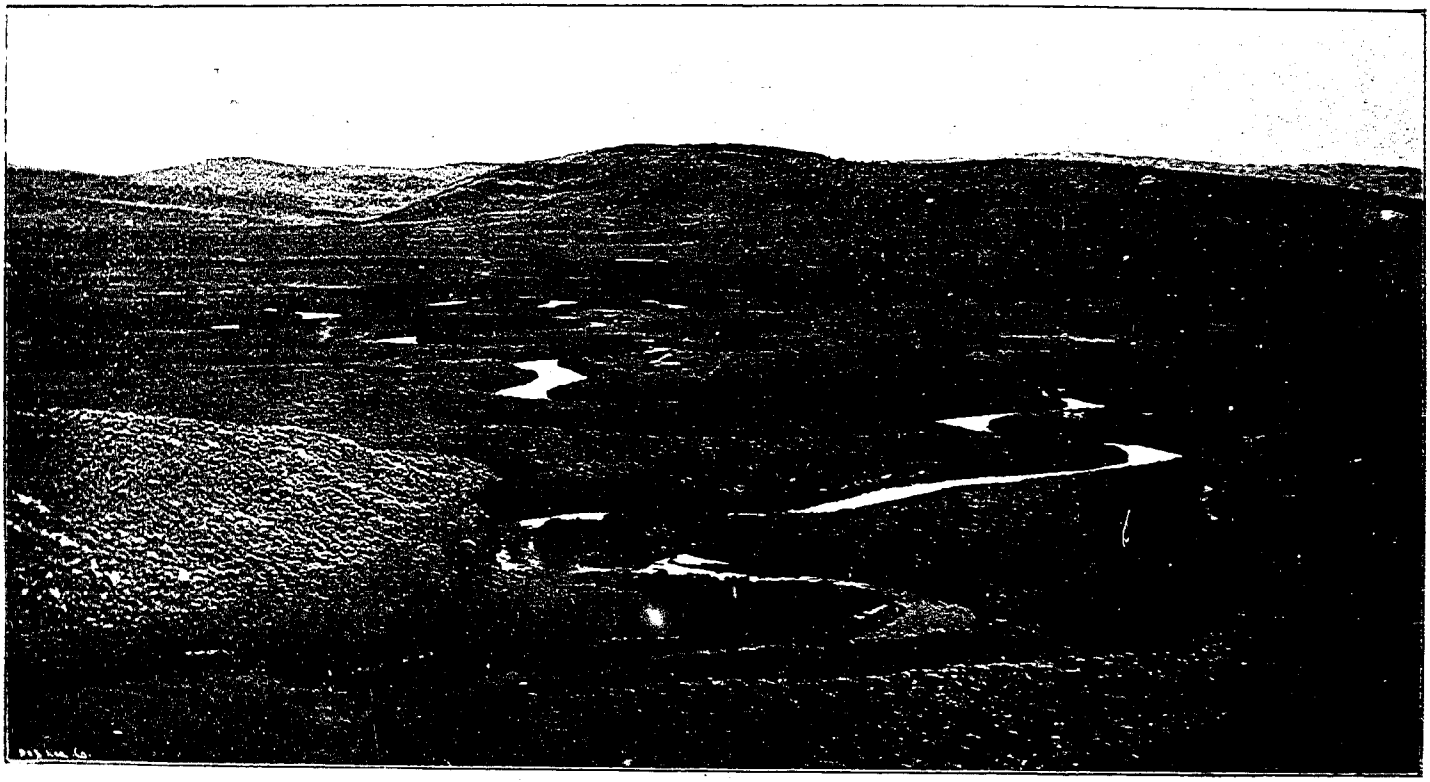
It is thought that by segregating from the lake its principal arms or bays, together with the margin of marsh and some strips of shallowest lake along the shore, and filling these segregations with mud pumped from the adjacent lake bottom, a material reduction of surface and increase in depth of water will result. In addition to this it is proposed to raise the lake surface to a higher level by allowing none of the water to run to waste from the lake at any time during any season. There is no doubt but that the filled marshes and lake segregations would be worth as much to Utah county as the increased water supply would be worth to Salt Lake county and that both would be greatly benefited through such work.

Committees have been appointed and are now at work endeavoring to combine and unify existing interests in order to forestall any litigation that might occasion delay and to induce the government to at once undertake the work. Very satisfactory progress along these lines is being made, and it is expected that in a very short time all the necessary preliminaries will have been disposed of and the way made clear for government action.

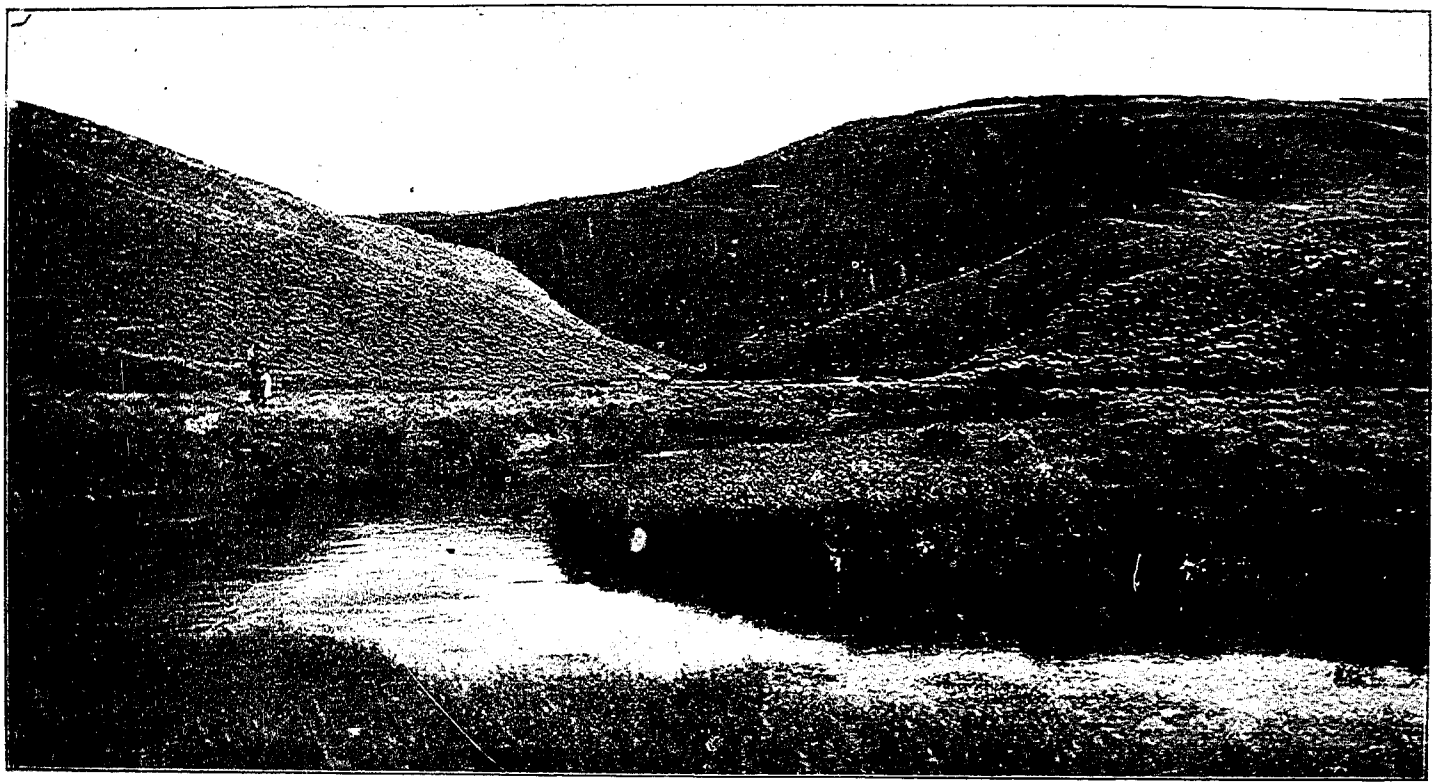
The Strawberry valley scheme contemplates as bold a piece of engineering work as any of the plans previously described. It is proposed to construct an earthen dam about forty-five feet high and 600 feet long across the main fork of Strawberry creek to form a reservoir in which it is proposed to store the surplus water of the creek. The dam will probably be located near the confluence of the two forks and the water of the smaller stream be conveyed into the reservoir by means of a canal, or a dam may be constructed in each fork near their confluence and by this means provide a double basin having a capacity of about 250,000 acre-feet.

It is proposed to utilize the stored water on a tract of about 45,000 acres of land which embraces the cities of Spanish Fork and Payson and the towns of Mapleton, Lake Shore and Benjamin, in the southern end of Utah valley. The water is to be brought, in a tunnel about three and one-half miles long, through the ridge between Bryan's fork of Strawberry and the middle branch of Diamond creek. The former is a tributary of the Du Chesne river and the latter of Spanish Fork river. From the tunnel mouth the water will be commingled with the Spanish Fork river water and with it be diverted through the present canal system on to the lands which it is to irrigate.

Like the Weber river plan, this is to be a co-operative organization of the people of the several towns and cities to be benefited. The lands which are now deficiently supplied will first be provided with a full supply and the water in excess of this requirement will be used upon the adjoining lands now without water. This is similar to the Weber river plan also with respect to its object, which is not the establishment of a new system, but to combine, preserve and extend the existing systems.



STRAWBERRY BASIN.



SITE OF PROPOSED DAM—STRAW BERRY BASIN.

A committee has been appointed to perfect all necessary preliminaries, and there is every reason to believe that the plan will soon be fully developed and its execution begun.

The Bear lake project, while of great importance to this state, is not wholly a Utah proposition, at least so far as its location is considered. The lake is situated partly in Utah and partly in Idaho. Exclusive of the extensive marshes that adjoin it on the north, the lake area is about 80,000 acres.

Various measures for utilizing the lake as a reservoir have been and are now being discussed. Most, if not all of these contemplate the construction of a canal from twelve to fifteen miles in length for conducting the surplus water of Bear river into the lake. It is thought that water to the depth of about four feet can be added to the lake without much expense for retaining it, as the natural barriers are nearly or quite sufficient for that purpose. This depth would afford about 320,000 acre-feet of stored water.

One plan that has been suggested for utilizing the stored water is to conduct it through the mountain ridge in a tunnel, of unknown length, to Cache valley, and there use it on the high bench lands. Another plan is to return the stored water to Bear river by means of a second canal which would discharge the water into the river at a point several miles below the intake of the first or diverting canal. The water would then be available for diversion by any of the canals which now take water from Bear river below Bear lake and could be utilized as supplemental to the present rights or in the reclamation of additional land, or for both. The latter plan would, perhaps, serve a more extended use than the former. Interstate rights may present obstacles to the execution of any plan unless the government should itself undertake the work.

It is understood that at least two private corporations are now at work upon plans for converting Bear lake into a mammoth reservoir, and the work will no doubt be accomplished in time.

It is here suggested that the reclamation of the extensive marshes that adjoin Bear lake should be included in any plan which has for its purpose the greatest saving

and utilization of water and the fullest subjugation of land. Both are important matters for consideration in this region where the ultimate improved area must be small in comparison with the extended area that will remain unimproved.

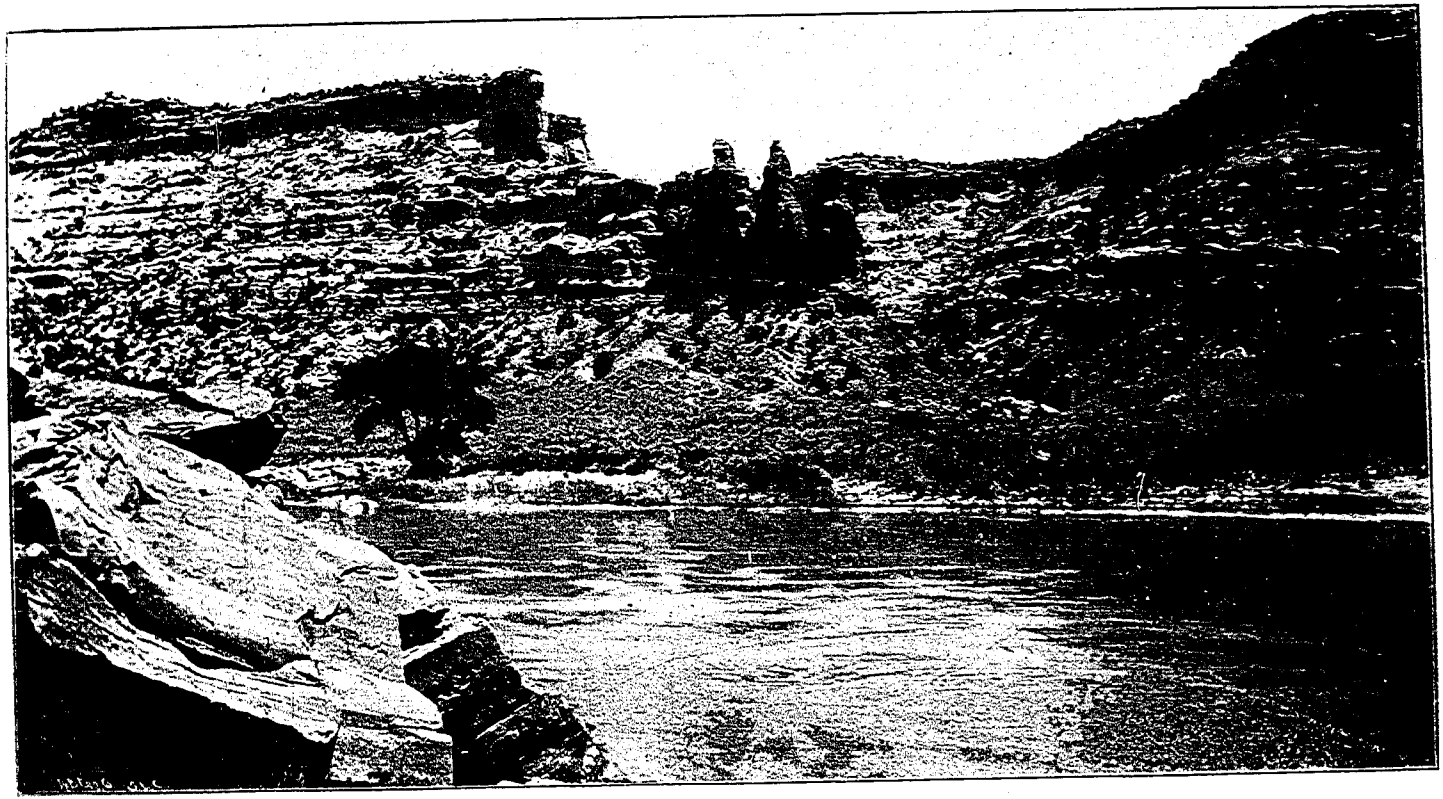
The Grand river canal is another important project calculated to increase the water supply of the state and has received much attention of late from the interior department officials. It is proposed to divert the Grand river at a point some distance beyond the Colorado line and bring the water into Grand and San Juan counties of this state for irrigating the large deltoidal tract of land that lies south of the Rio Grande railway and between the Green and Grand rivers.

This will require the construction of a long canal of large dimensions over ground that is badly broken and along slopes that are rough and steep. The cost will be considerable, but it is thought that this will be fully justified by the benefits. The land and location are counted among the best in the state. The soil and climate are well adapted for fruit growing and also for most kinds of farm crops. Transportation facilities are ample, and the situation is said to be of great promise.

Colorado has no land upon which the water of the Grand River can be utilized and her people are the proponents of this project, with the view, perhaps, of opening a new field of business which would be naturally contributory to that state. Inasmuch, however, as it will be in the direction of upbuilding Utah, we can well afford to recognize and aid the undertaking.

While the above described projects are the most prominent they are by no means the only measures that are being carried out or considered in the interests of irrigation. A general movement toward the same end is noticeable throughout the state. It is also noticeable that only one of these projects, the Grand river, has for its object the establishment of a new system. All the other plans are for the preservation and betterment of existing systems. This is truly indicative of the situation and needs of the state as to irrigation. There is little opportunity left for new systems. There is great need of improving and extending the old ones. Practically all the initiatory work has been done. There is imperative

GRAND RIVER CANYON.



GRAND RIVER.

need for perfecting and so preserving and expanding the work initiated. Observation affirms the general need for betterment of the existing systems and also indicates the ampleness of opportunity for such work.

There are few systems where half of the available water is not wasted—part through imperfect methods of application, part through absorbent canals and river channels, and part as flood and winter flow. Apportionment of the meager remnant is the cause of ceaseless contest. Flood and drought alternate with never failing regularity. Denuded watersheds exist everywhere and augment the inequality of the flow. The uncertainty that results suppresses hope, cripples confidence and conduces to greatly hinder progress.

The perfection of the systems and the expansion of irrigation in Utah are contingent upon the removal of these impediments. This involves the reformation of existing methods and channels, the definition of conflicting rights, the construction of ample reservoirs, and the adequate protection and control of the systems. Cooperation to save in place of contention to sap the several systems must become the rule. Earnest and unselfish action will be essential. Helpful legislation will be equally indispensable.

The definition of existing rights appears to be of first importance. This is not only necessary to pacify present contention but to prevent future conflicts and encourage further progress. There can be no safe basis for future work before existing rights are known and made of public record. All future work and rights on existing systems must be based on the remnant of unappropriated water of these systems. The extent of this remnant cannot be ascertained before the measure of appropriated water is known, and as the sum of the existing rights is the measure of the water appropriated it is evident that the extent of the remnant cannot be known before the existing rights shall have first been determined.

To defer the definition of these rights is not only to prolong the present general conflict but to extend the cause of contention by permitting the number of uncertain rights to increase. In the meantime all plans for betterment, including the important projects hereinbefore described, must of necessity be based on no better

foundation than that of uncertain rights and be liable to the same disturbance, litigation and loss that involve all present undefined rights.

It is true that the fear of future trouble from this source has not prevented some of the projects already described from development, but this was the result of a necessity which compelled action for self-preservation, in spite of these well known difficulties. The course of all these would be made infinitely easier if relieved of the encumbrance which indefinite right imposes.

The importance of defined rights to water appears to be generally well understood. President Roosevelt in his first message to Congress refers to it in the following language:

"Whatever the nation does for the extension of irrigation should harmonize with and tend to improve the condition of those now living on irrigated land. . . . The security and value of the homes created depend largely on the stability of titles to water; but a majority of these rest on uncertain foundation. . . . The arid states have failed to provide for the certain and just division of streams."

Secretary Wilson of the Department of Agriculture in his report for 1901, says:

" . . . rights have been established . . . yet there is nothing to prevent new claims being filed, new diversions made, and unending litigation over the conflicts thus created. For the government to provide an additional supply on these streams before existing controversies are settled would simply aggravate and intensify the evils of the present situation. Whatever aid Congress extends should be conditioned on the enactment of proper irrigation codes by the states. . . . "

The states of Wyoming and Nebraska have enacted special laws relative to the definition of water rights. California is said to be ready for similar legislation.

Professor Elwood Mead, expert irrigation engineer of the Department of Agriculture, is a stanch advocate of the doctrine that a definition of rights is the primary need of present day irrigation.

Professor Newell, chief engineer of the Department of the Interior, in an address to the Utah Irrigation Congress, prescribed "the settlement of all conflicts" as a

condition precedent to any action of the government under the recent act of Congress in aid of irrigation extension. This is tantamount to a requirement of the definition of rights and seems to be necessary to proper order and safety.

From a business standpoint, a knowledge of existing rights seems indispensable as a safe foundation for either individual, corporation, community or government undertakings which have in view the utilization of the remnant of any of the existing systems of the state.

On the few streams where no systems have yet been established there is, of course, no question of rights to settle, and the fundamental need in such situations is a systematic and orderly method of appropriation which will insure exactness of the right initiated and so prevent subsequent conflicts. Similar procedure is also necessary in appropriating the remnant of any existing system. The would-be appropriator of water is entitled to know before he undertakes to establish his right whether or not there is opportunity on that system for additional rights, and the established rights are also entitled to protection against attempts to establish additional rights on systems where the water has already been fully appropriated. Such desirable and orderly method is, of course, impracticable before the definition of existing rights shall have been effected. Neither is just apportionment possible before that time.

In the physical work of perfecting our irrigation systems, reservoir construction ranks first in importance. No system can be complete without reservoirs. Reservoirs are to the irrigation system what vaults are to the bank or bins to the barn. They are necessary receptacles in which to store and preserve the unused substance of the system. Their purpose is to preserve in times of plenty what will be indispensable in times of scarcity; to restrain floods and prevent drought; to regulate the supply of water and so insure against failure of the dependent crops. The future irrigation system without a reservoir will be rated as hazardous as the banking house without a safe. Reservoir construction should be encouraged in every possible way. It is expensive work and will necessarily require time for full accomplishment. The first efforts will probably be to store the surplus water of a single

season for the purpose of equalizing that season's flow. Later the accumulated excess of several seasons will be held to equalize the flow for a corresponding period of time. And so the work will be gradually enlarged until finally there will be no waste of water whatever.

From the very beginning this work should be made secure and permanent; otherwise expensive and perhaps destructive but unnecessary failure may ensue. The requirement of existing law to the effect that plans and specifications for all such work shall receive the approval of the State Engineer, is not sufficient to prevent faulty work. It is more important that the work be faultless than that the plans be perfect, and, therefore, to approve the works instead of the plans would give the greater security. It is safe to say that the work done under existing conditions is always inferior to the requirements of the approved plans and specifications. The present law is defective in not prescribing a penalty for failure to submit plans and specifications prior to commencing the work of construction.

The perfection of our irrigation systems and their ultimate utility depend largely on the measure of protection that is extended to them during the period of their development. Starting a system by the work of diverting the water through easily constructed ditches onto near-by land is a short and simple matter compared with the work that is subsequently to be done. Yet this initial work contemplates the other as completely as turning the first sod or laying the first rail on a railway system contemplates its final completion, including all necessary equipment and other accessories and betterments. On irrigation projects, as on other great undertakings, the initial work should be accepted as an earnest as well as an index of the purpose. Pointed in this way our Utah systems suffice both in beginning and in breadth of purpose.

The paramount purpose of an irrigation system is the full utilization of its water supply by the community that has established itself permanently on the system; and whatever is calculated to defeat this purpose is hurtful and should not be permitted. All the irrigation works on each river system of our state are here regarded as parts of a single irrigation system which is coextensive with the river system itself. This, the writer thinks, is

the natural and only correct view of the limits of an irrigation system of this state and of other states where the situation is similar.

On such a system it is the rule that the water users have acquired more land than is put under immediate irrigation, the evident purpose being to secure as much land as the ultimate water supply of the system would serve and by gradual improvement of the system utilize more and more of the water and subdue more and more of the land until finally both water and land would be utilized in the greatest degree possible. But unless these systems shall be properly protected this purpose can never be fully realized.

Under existing law and practice no system is secure against invasion. Any individual or company electing to do so may now enter upon any irrigation system and deprive it of any portion of its unused water supply regardless of the initiatory work done and the subsequent development work performed and planned by the water users and land owners of the system in pursuance of the original purposes and ultimate needs of the system. One system may be invaded by the people of an adjoining or neighboring system and be despoiled of part of its water supply which may be conducted away and used by the adjoining or neighboring system upon land of less value than that of the invaded system from which the water has been taken.

Power companies may establish themselves on any of our irrigation systems and acquire rights to a continuous flow of the stream regardless of the purpose and need of the system to have the flow of flood and winter water repressed during times when irrigation has ceased and reservoirs are being replenished. The water employed by these plants is worth more for its wetness than for its energy and should be preserved for the greater purpose. Plants of this character are desirable as helps to the systems but not as hindrances. Their proper place is above the points of present or possible reservoirs; or, if below, their use of water should be restricted to the irrigation season alone.

Railways are often located through an irrigation system without reference to the ultimate needs of the system, and in this way valuable reservoir sites are frequently destroyed or their utilization prevented by the prior

right of the railway. All the necessary reservoir sites on every irrigation system should be definitely located and made of record and all subsequent railway or other similar construction should be subordinated thereto. This should not preclude the railways but only prevent their interference with paramount projects.

With few exceptions the watersheds of our irrigation systems are occupied by adverse interests, such as lumbering and grazing, and have been denuded to an extent that greatly injures the systems and disturbs the people. Lumbering and grazing are important; irrigation is indispensable. Limited irrigation has transformed natural deserts into parks; unlimited lumbering and grazing have transformed natural parks into deserts. The latter interests should not be suppressed; the former must be fully protected. The watershed of each system is of paramount value as the source of the water supply for that system, and its preservation for that purpose is of the utmost importance. A barren, hoof-beaten shed dissipates the rainfall; a well covered, untrodden shed conserves the rainfall. To protect the shed is to perpetuate the system and preserve the people; to despoil the shed is to deteriorate the system and destroy the people.

Control of our irrigating systems is a manifest necessity. Without control there can be no protection, and damage and confusion are unavoidable. Divided control is ineffectual and undesirable. Any control to be effective must be single and in other respects ample. Community control is most desirable and must in the end prevail. In the meantime suitable control is greatly needed and must be generally established and recognized. Our present plan involves much enginery and little effect.

As a rule the systems are under a divided control in which the general government has ostensible and trespassers actual control of the watershed; the water users have possession and control of the irrigable lands and the county has control of the water supply and general operation of the system. If the system extends into more than one county, each county controls the water supply and operates that portion of the system which is within its borders.

The plan resembles that of a railway system where the land on which it is built belongs to the government, the tracks and equipment to the stockholders, and its op-

eration is by divisions that are limited to county lines, regardless of any other consideration or necessity, and under general direction and control of the county commissioners of the respective counties through which the road may pass. Any train that might finally reach the lower division of such a railway system would no doubt resemble the stream which now escapes to the lower division of the irrigation system under present control

The law provides that the state shall also take part in the joint control of our irrigation systems, but the conditions imposed are such as to have practically prevented such participation. Quantity rather than quality of control seems to have bee nthe rule of legislation with respect to these systems.

Primarily, both the land and water of these systems were under the sovereign control of the general government. Under such control the land was carefully measured and disposed of in definite tracts and in a systematic and orderly manner. The water was not measured, nor was it formally disposed of. At that time it was probably considered as having passed in needed but unmeasured quantity with each piece of aliened land which was known by both grantor and grantee to be valueless for the purposes acquired without the necessary quantity of water with which to irrigate it.

Local customs, however, soon established certain general rules relative to rights to the use of water. The rights so acquired, although very indefinite, were afterwards recognized but not defined by the general government. Finally state sovereignty succeeded that by the general government over both the water and the land. The government reserved proprietorship of the land and continued in control of its disposition. No reservation was made as to proprietorship of the unused water, nor was any attempt made to dispose of or regulate its use. That was left entirely to the state which was then obligated by its sovereignty to assume full control of the water and to make and enforce rules for its orderly disposal. This was neglected and the confusion of undefined rights, which was inherited with statehood, has continued, and each subsequent appropriation of water has contributed to effect the present entanglement which existing law has not been adequate to prevent.

No further uncertain appropriations of water should be allowed. The extent of the remnant of unused water should be determined by or with the assistance of the state, and the people of the proper system be allowed to appropriate it according to their respective needs and under sufficient regulations until the full supply shall have become exhausted. Government control of the land and state control of the water are essential only to their definition and orderly disposal. Management of either after their alienation is not a government or state affair, but is a right which attaches to and ceases with proprietorship.

When the remnant of land of any system shall have passed to the ownership of the people of that system government control will have gone with it. When the remnant of unused water of the same system shall have passed to the use of the people of the system, state control will have passed with it and there will then be neither government nor state control of that system. The necessity for both will have disappeared. Community control will have succeeded both in proper manner and time. The transition will have been gradual and therefore well founded. Co-operation of all the people of the system will then be necessary to accomplish fully the work of perfection and management.

The state, either as sovereign or proprietor, has no right to refuse nor to retire from control of its water supply until after its definite and peaceful distribution among the people shall have been affected. The counties have neither right nor qualification to participate in the matter of either control or management and should be eliminated.

Legislation which will enable the earliest possible accomplishment of these ends is most earnestly recommended.

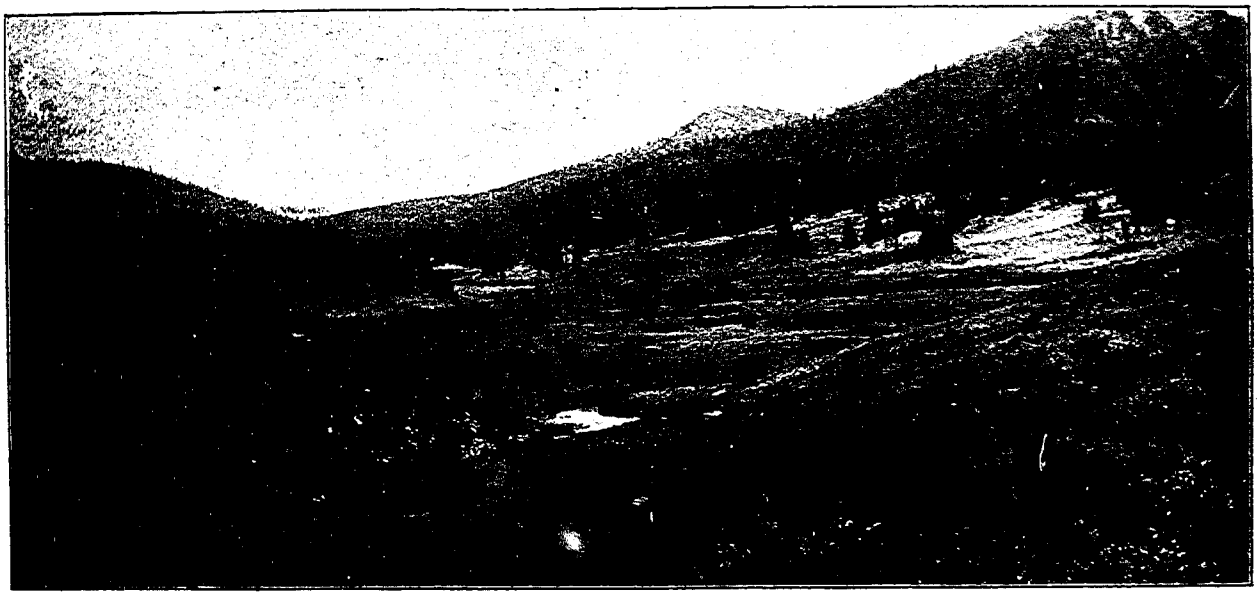
Notwithstanding the many discouragements which our people have had to meet during the past two years, there is a noticeable improvement both in feeling and in fact. Knowledge of a disabling cause leads to a desire for its removal, and a more general knowledge of these causes has awakened a new interest in the old problems of irrigation which is most encouraging. This general enlargement of knowledge is due in no small measure to the work of the United States Department of Agriculture.

The irrigation and soil surveys of this department have been highly beneficial to the state, and it is hoped they will be continued and enlarged.

Recent national legislation in behalf of irrigation has greatly stimulated both local and general interest. The operation of this law is expected to result in much permanent advantage to the state and the people.

Upon the whole the outlook for irrigation in Utah is most promising, and its ultimate improvement and enlargement is only a matter of such effort as friendly aid and favorable legislation will assure.

STILLWATER BASIN—BEAR RIVER SYSTEM.



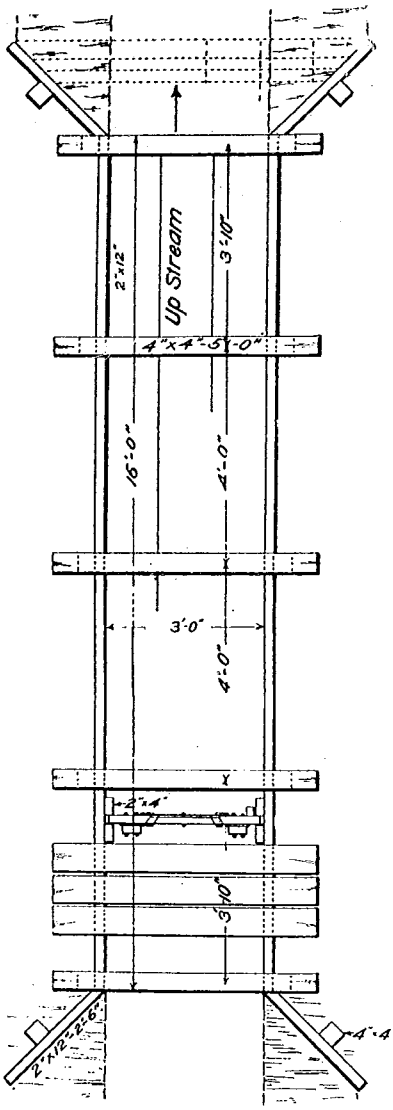
WEST FORK BASIN—BEAR RIVER SYSTEM.

COMBINED WEIR AND RATING FLUME
FOR
ACCURATELY MEASURING AND APPORTIONING FLOWING WATER

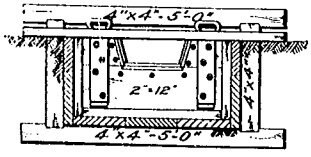
STANDARD DESIGN FOR WEIR HAVING CREST 1 FOOT
IN LENGTH AND CAPACITY OF 0.4
CUBIC FEET PER SECOND.

State Engineer's Office, Salt Lake City, Utah, 1902

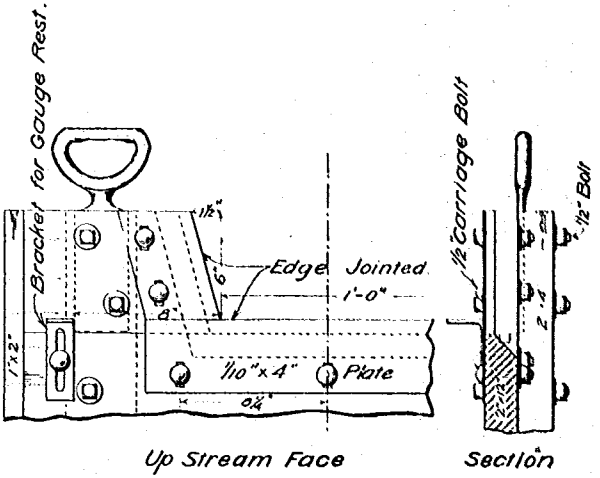
A. F. Doremus,
State Engineer.



Plan



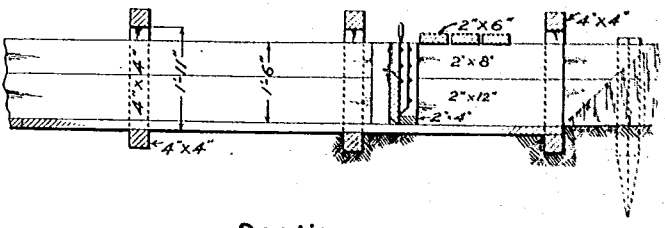
Elevation



Up Stream Face

Section

Weir Crest



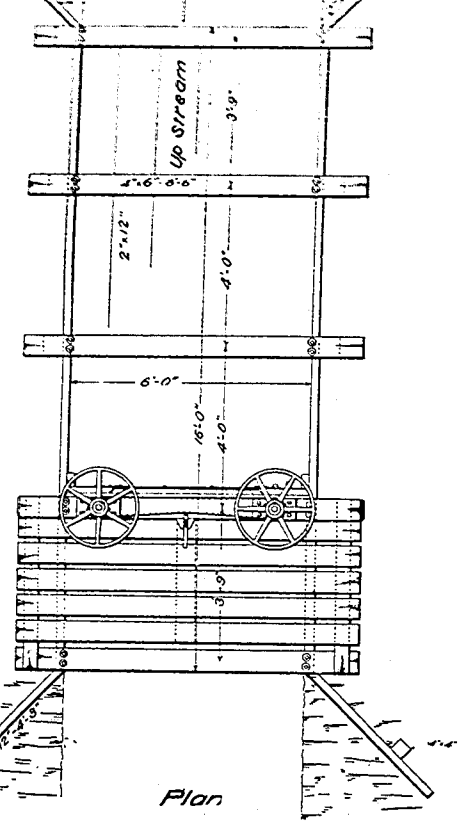
Section

STANDARD DESIGN FOR WEIRS HAVING CRESTS FROM 2 TO 4 FEET IN LENGTH AND CAPACITY OF FROM 3 TO 8 CUBIC FEET PER SECOND

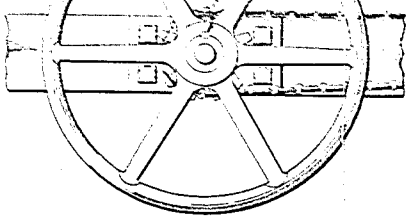
State Engineers Office, Salt Lake City, Utah, 1902

A. F. Doremus, State Engineer

Length of Weir Crest	Dimensions of Flume		
	Length	Width	Depth
2 Ft.	10 Ft.	5 Ft.	3 Ft.
3 Ft.	10 Ft.	6 Ft.	3 Ft.
4 Ft.	10 Ft.	8 Ft.	4 Ft.



Plan



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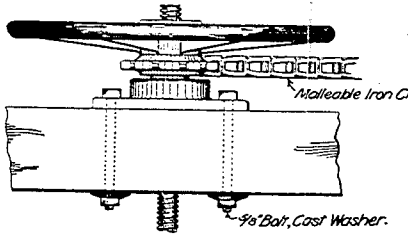
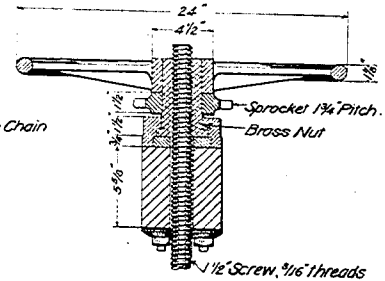
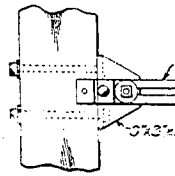


Elevation

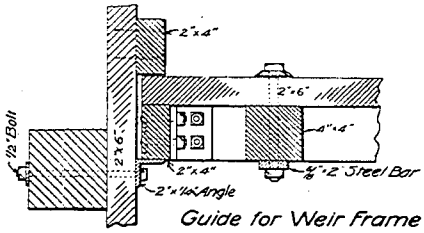


Section

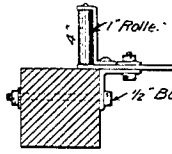
Hand Wheel



Plan

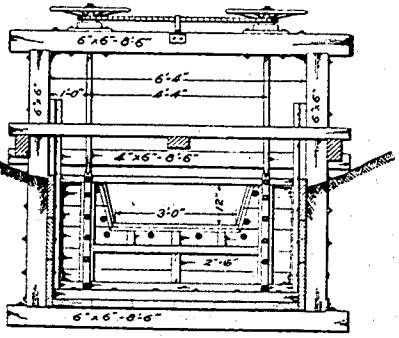


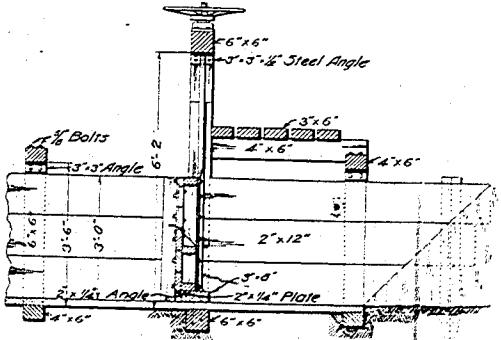
Guide for Weir Frame

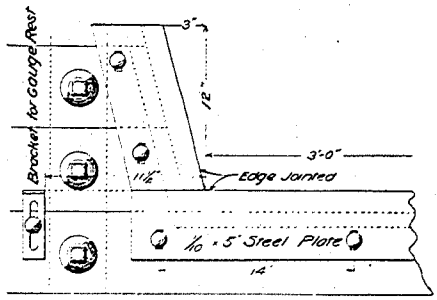


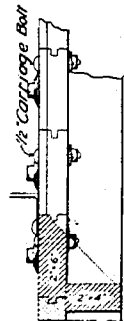
Side Elev

Chain Tightener







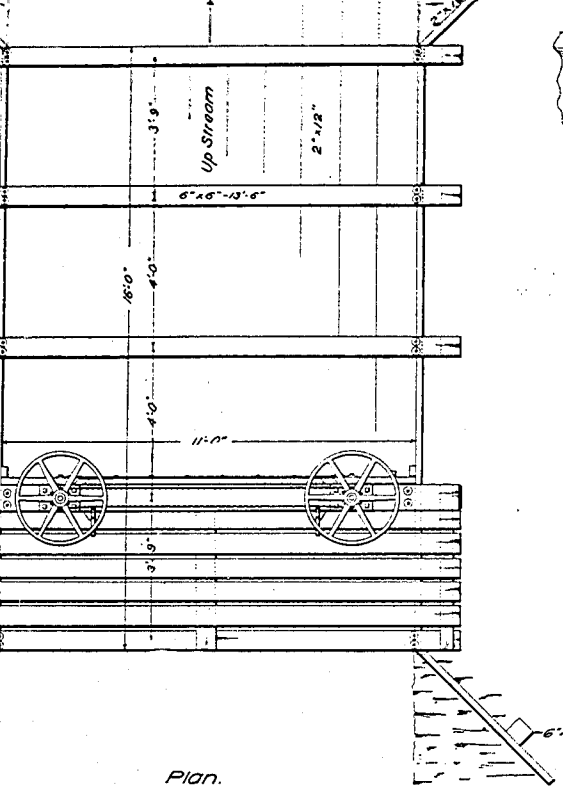


STANDARD DESIGN FOR WEIRS HAVING CRESTS FROM 5 TO 10 FEET IN LENGTH AND CAPACITY OF FROM 10 TO 34 CUBIC FEET PER SECOND

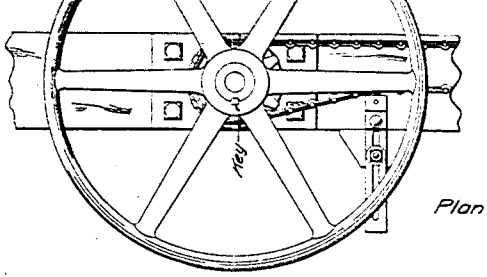
State Engineers Office, Salt Lake City, Utah. 1902.

A. F. Doremus, State Engr.

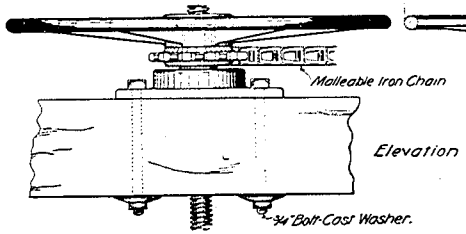
Length of Weir Crest	Dimensions of Flume		
	Length	Width	Depth
5 Ft.	16 Ft.	9 Ft.	4 Ft.
6 Ft.	16 Ft.	11 Ft.	4 Ft.
7 Ft.	16 Ft.	12 Ft.	4 Ft.
8 Ft.	16 Ft.	14 Ft.	5 Ft.
9 Ft.	16 Ft.	15 Ft.	5 Ft.
10 Ft.	16 Ft.	16 Ft.	5 Ft.



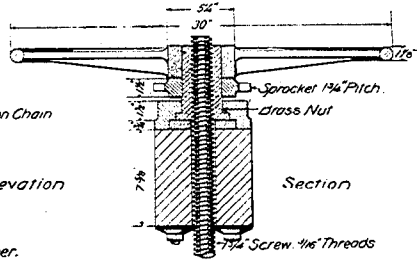
Plan.



Plan

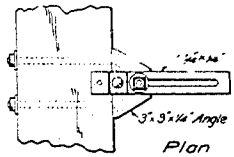


Elevation

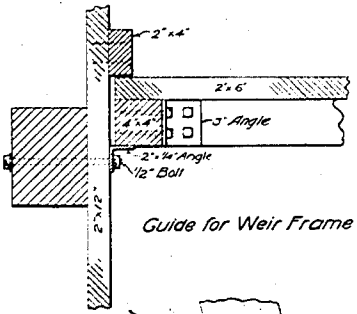


Section

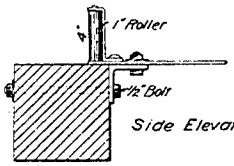
Hand Wheel



Plan

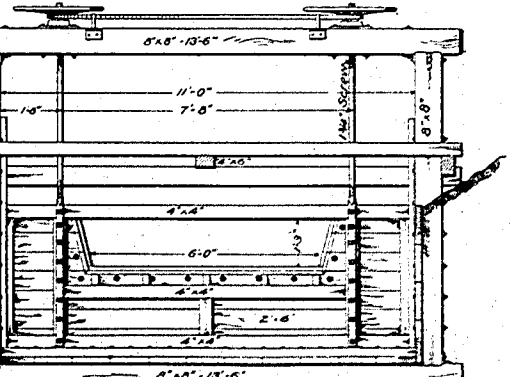


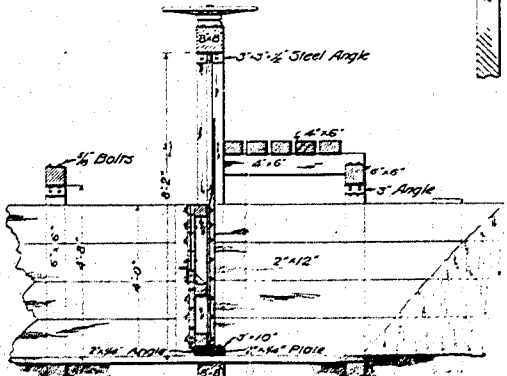
Guide for Weir Frame

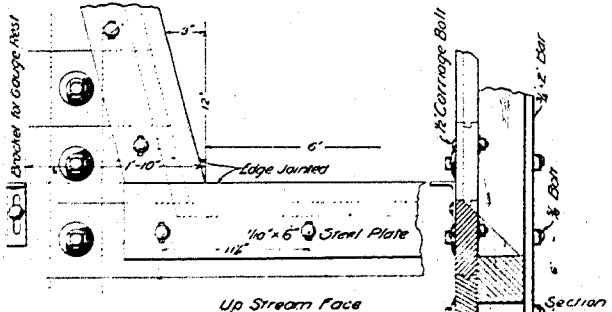


Side Elevat.

Chain Tightener







Up Stream Face

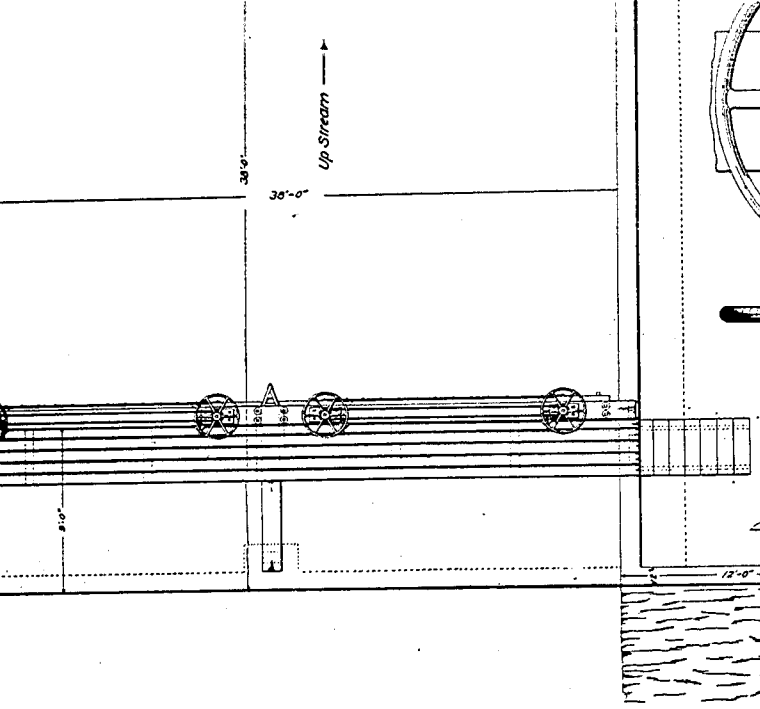
Section

STANDARD DESIGN FOR DOUBLE WEIRS HAVING CRESTS FROM
6 TO 12 FEET IN LENGTH AND CAPACITY OF FROM
55 TO 230 CUBIC FEET PER SECOND.

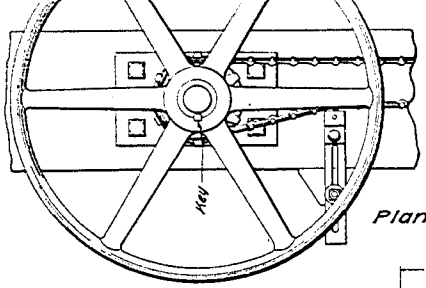
State Engineer's Office, Salt Lake City, Utah, 1902

A. F. Doremus,
State Engineer.

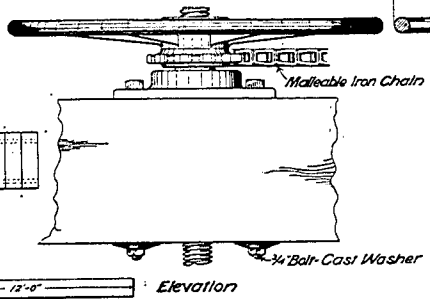
Length of Crest	Dimensions of Flume		
	Length	Width	Depth
6 Ft.	24 Ft.	24 Ft.	6 Ft.
8 Ft.	30 Ft.	30 Ft.	7 Ft.
10 Ft.	36 Ft.	36 Ft.	8 Ft.
12 Ft.	44 Ft.	44 Ft.	9 Ft.



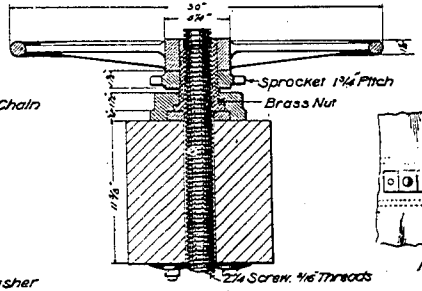
Plan



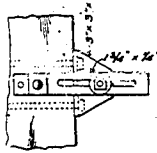
Plan



Elevation

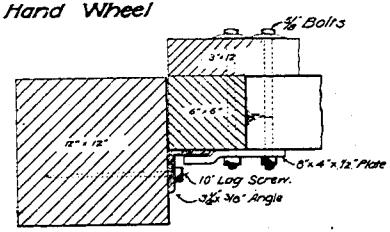


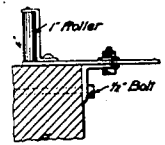
Section



Plan

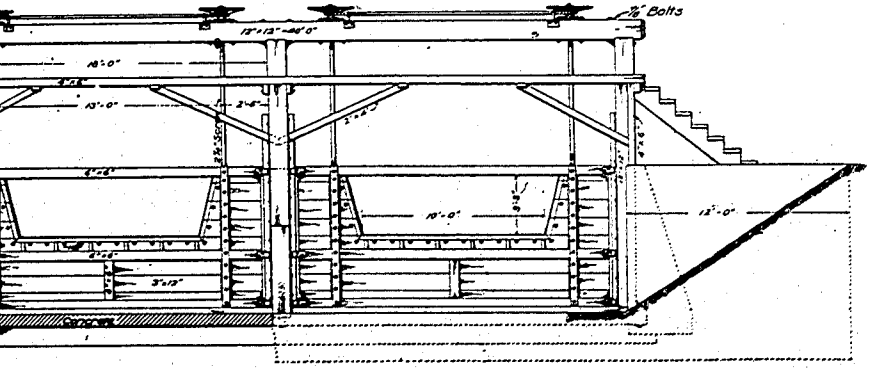
Hand Wheel

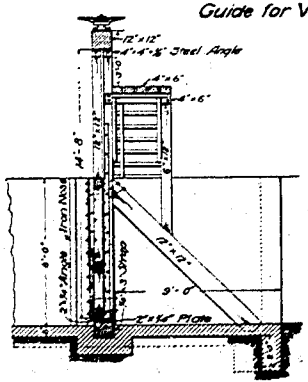




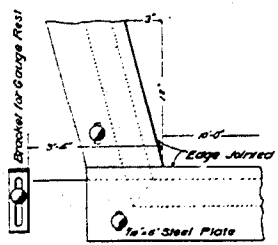
Side Elevation

Chain Tightener





Guide for Weir Frame



Up Stream Face